Development of Software-Defined Multichannel Receiver for Equatorial Atmosphere Radar (EAR)

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Equatorial Atmosphere Radar (EAR) is a very high frequency (VHF) Doppler radar operated with an active phased-array antenna system at 47 MHz. It had originally been equipped with a single receiving channel system since its establishment in 2001 at the equator in Kototabang, West Sumatra, Indonesia (0.20S, 100.32E). We have developed a multichannel receiver system for the EAR using a combination of the Universal Software Radio Peripheral X300 (USRP X300) and GNU Radio software. There are a number of advantages to have multichannel receiver systems such as to enable spaced-antenna method and spatial domain interferometry.

Two USRP X300 devices, corresponding to four receiving channels, were synchronized using 10 MHz reference clock and a pulse per second (1 PPS) signal. The standard observation system of the EAR is retained by splitting the received echo signals through directional couplers which enabled simultaneous observation of the two different techniques, spaced-antenna and Doppler beam swinging. The signal <gwmw class="ginger-module-highlighter-mistake-type-3" id="gwmw-15814652745326432130038">for</gwmw> spaced-antenna application is fed to the USRP X300s for digital conversion, and then stored on a Hard Disk Drive (HDD). The <gwmw class="ginger-module-highlighter-mistake-type-2" id="gwmw-15814652881083188773963">ranging</gwmw> of the data is carried out by taking advantage of the leaked transmitted pulse, before demodulated and coherently integrated.

Performance analysis using multiple receiving <gwmw class="ginger-module-highlighter-mistake-type-3" id="gwmw-15814652985556454852304">antennas</gwmw> orientation for the application of spaced-antenna methods on the EAR has been carried out through multiple experiments over the duration between April 2019 and September 2019. Phase correction is applied to all channels for a single spectrum in the real time signal processing for improving the phase synchronization. The initial results show the existence of noticeable fluctuations in the estimated horizontal wind. Then, a comparison of the EAR spaced-antenna (SA) performance with five different orientations taking into consideration the size of receiving antenna and its separation distance has been presented, where the horizontal wind profiles using Full Correlation Analysis (FCA) were estimated and compared with the standard EAR data. Based on the results, the configuration with the largest aperture shows slight advantages over the other four configurations but with limited improvement.

We can apply the achievement of this study to the Equatorial MU radar (EMU), which is proposed to be constructed at West Sumatera, Indonesia. The EMU system is the similar to the MU radar, but its antenna consists of 1045 Yagi antennas with 55 groups and it has 64 receiver channels.

Keywords: Software Defined Radio, Equatorial Atmosphere Radar, Multi-Channel Receiver

